Identification Of Vehicle Type And License Plate Number Using Different Types Of Neural Networks: A Survey

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Abstract—An accurate system or software which identifies vehicle type and license plate can enhance the road safety, help in reducing criminal activity and also help to optimize traffic flow using cameras, leading us towards a more secure future aided with AI integrated transport systems. In this paper we have have surveyed different techniques for vehicle type and license plate identification and have given a background theory, issues and benefits regarding the techniques used, a literature survey and concluded and summarized the survey in a tabular format leaving the reader to decide the best choice for vehicle type and license plate identification along with references.

Keywords—Vehicle Model Recognition; License Plate Recognition; Neural Networks; Deep Learning; Convolutional Neural Network. Object Detection; Multi Modal Sensing; Vector; SIFT; Radial Basis Function; Symmetry Filter.

I. INTRODUCTION

Vehicle type and License Plate Identification can help in getting more detailed information of the vehicle and can aid the traffic policemen in optimizing the traffic through software since the number of vehicles on the roads are increasing day by day at an exponential rate and then it becomes difficult for human supervision.It can also be used to detect accidents on highways and collection of tolls.One of the most interest uses is operation of the traffic lights in accordance with the type of vehicle detected. For examples all the traffic lights must be turned to green if an ambulance is rushing. It also helps increase the safety of the users and pedestrians as well. Vehicles can be tracked thereby helping to reduce criminal activity. Latest areas like object detection and image classification mimic the way a human learns and tries to replicate a primitive version to help a computer learn what humans can do. It is theorized that computers will be able to classify things and items using sight, smell, touch, sound or a combination of either of these. The machine is trained with existing data-set and then the machine is able to predict a satisfying result close to our expectations by receiving inputs similar to the ones in the training data-sets. Today we can make use of humungous amount of data (BigData) and we simply need an efficient system for classification, analysis and appropriate use of it.

Some methods implement the following; they capture some of the features of the car (mainly frontal and rear in beginning days.) and compared them to already stored templates of vehicle model to give th desired output. Petrovic and Cootes used nearest neighbor algorithm to achieve this [38]. Later only the key points of the vehicle were captured and used. Dlagnekov [3] used this method by using Scale Invariant Feature Transform (SIFT) features [4].

The main problems for vehicle detection are large variation of light, dense occlusion, large variation of object scales and varying weather conditions [1].

The following techniques discussed in the paper are operated under controlled conditions. (Fixed weather, constant weather, same illumination.) and one of the case studies is also on uncontrolled conditions.

Advances in GPU's high processing power and theoretical advances in large neural networks have given way to development of strong techniques resulting in better accuracy discussed below.

This Paper is divided into five sections with the first section giving an introduction to the topic , the second section talks about some filters and methods for preprocessing and listing and defining the most popular technique used today for classification, the third section giving an account of the issues faced when these techniques are used, the fourth section consists of a literature review giving an in-depth analysis of the new techniques proposed and the fifth section gives the conclusion of the authors.

II. BACKGROUND THEORY

Before operating on any image, it has to be processed first to improve it's quality to help make the process of classification easier and more error free. Processing mainly consists eliminating defects and noises. To improve the contrast, equalization of histogram is used. It deals with histograms and graphs taking into account the pixel intensity the photo and tries to flatten the histogram.[31][32]

Fig1. Improved Contrast Through Histogram Equalization

Techniques such as median filter are used to reduce the noise.[1]

• Copying pixels in a T-table (n-k pixel).
• Sorting the table (sorting by insertion, sorting by selection, sorting bubbles).
• The median is in the middle, in T [n/2]

Fig2. Noisy Image

Fig3. After applying median filter

A. CONVOLUTIONAL NEURAL NETWORK

A Convolutional Neural Network (CNN) is a feed forward network mainly used in classifying the image of interest. It mimics the activity of the neural nets in the biological brain. It has some convolution layers and then it follows the architecture of the Artificial Neural Network(ANN).

$$Y_n = activation\left[\sum_{m=1}^{m}(X_m . W_{mn} + bias_{mn})\right] \quad (1)$$

$$\begin{bmatrix} Y_1 \\ \vdots \\ Y_n \end{bmatrix} = activation\left(\begin{bmatrix} w_{11} & \cdots & w_{m1} \\ \vdots & \ddots & \vdots \\ w_{n1} & \cdots & w_{mn} \end{bmatrix} . \begin{bmatrix} X_1 \\ \vdots \\ X_m \end{bmatrix} + \begin{bmatrix} bias_1 \\ \vdots \\ bias_n \end{bmatrix}\right) \quad (2)$$

In ANN, the Yn represents the output which is processed by the activation function (eg.sigmoidal, binary, bipolar, purelin, poslin) which acts upon the product of the inputs with weights associated and it's sum with the bias.

The image is broken down into small squares (pixels) and it is stored as an array in the form of colors on RGB scale. To be more precise the convolution layers have the task of extraction of key characteristics of the image while the remaining ANN network does the work of classification.

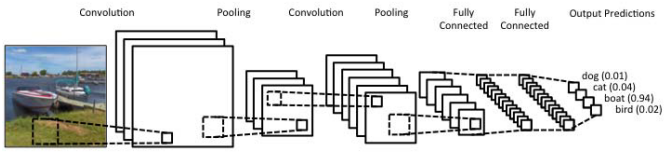

Fig4. Bird's Eye View of the CNN [5]

The convolution layers consist of three different layers; the filter bank layer, the non-linearity layer and the characteristic pooling layer [6]. The more we increase the number of convolution layers, the more time and costs is incurred.The input and output of convolution layer consists of matrix of three dimensions. The first two are height and width while the third (in this case) is RGB cards. It means that a single image fed into the CNN will have three images to represent it, each with it's own color channel (Red, Green and Blue.)[7]

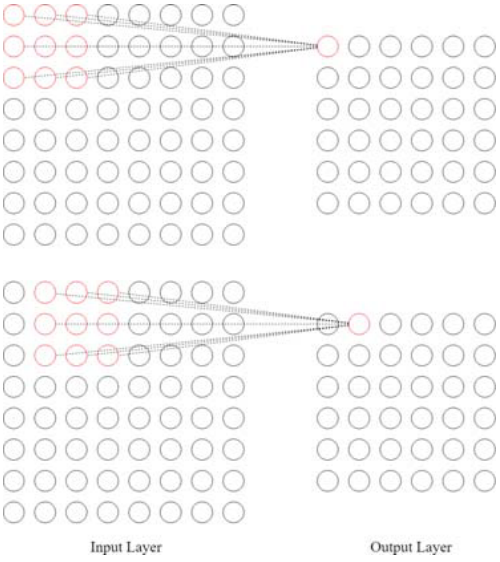

Fig5. 3D Inputs and Outputs

A pooling function is placed after the convolutional layers to decrease the size of the intermediate layers and reduce the cost of the process; especially max pooling [4] function is used as it brings quicker convergence and increases the ability of the model to select more distinct features.Instead of summing the pixels with the weight of the filter only the pixel with the highest value will be passed to the output. It helps in reducing the noise but the image has to be set at a lower resolution.

The Relu layer is used to gain the non-linearity of the network. This layer uses the non-saturating function which has the non-linear property and has no affection of the receptive fields of the convolution layer.[35]

There is one more layer called batch normalization layer[36] which was a new proposed method which reduces the number of iterations required by the convolution neural network.

Visual object recognition refers to the ability to identify the objects in view based on visual input. One important signature of visual object recognition is "object invariance", or the ability to identify objects across changes in the detailed context in which objects are viewed, including changes in illumination, object pose, and background context

"Object constancy" theory :

A significant aspect of object recognition is that of object constancy: the ability to recognize an object across

RECOGNITION BY COMPONENTS THEORY :

An extension of Marr and Nishihara's model, the theory proposed by Biederman (1987), proposes that the visual information gained from an object is divided into simple geometric components, such as blocks and cylinders, also known as geons(geometric ions), and are then matched with the most similar object representation that is stored in memory to provide the object's identification. A similar method is used in our neural networks classification process wherein the feature extracted through global features extraction method[38] and Scale Invariant Feature Transform (SIFT) [39] are compared to already stored templates of the features obtained from training data set.

III. ISSUES AND BENEFITS INVOLVED

Convolutional Neural Network is a deep learning algorithm which can take in an input image and assign importance to differentiate image. It can easily detect the main features of a car without having to use any human supervision and is more efficient in terms of memory and complexity. One of the main disadvantage is the fact that it cannot encode the position and orientation of the object, it makes its prediction by looking at an image for its image components ,this is the feature of the pooling layers, as a result a lot of information about the vehicle (in this case) could be lost since it would pay attention only to certain features of the car and not the image as a whole and hence could give us the wrong output or the neuron might not fire up due to translation invariance. CNN does not have a built in understanding of 3D space and works in a 2D environment or 1D only. [28]

Pulse coupled Neural Networks (PCNN) [2] are biologically inspired neural networks inspired by a cat's visual cortex. No training process is required in the PCNN. The PCNN is very well known for being a pre processor in image processing and particularly helps with image segmentation ,edge detection,image object isolation and contrast enhancement but for a larger number of parameters estimating optimum values could be difficult ,and the complexity for feature generation is too high.

Recurrent Neural Network (RNN) is an artificial neural network commonly used in speech recognition and natural language processing where connections between nodes form a temporal sequence with directed graph. An RNN retains each and every information through time by making each sample dependent on each other and this feature of the network is called Long Short Term Memory. In a recurrent neural network convolutional layers can also be used to extend the effectiveness on a pixel and its surrounding pixels. Layers that are deeper, go through a lot of matrix multiplications to compute derivatives. Now if the derivatives are large, then the gradient will keep increasing exponentially. The more further we go into the model the more it will increase and eventually the derivative will explode "Exploding Gradient". On the other hand if the derivatives are small then the gradient will start to decrease exponentially. The more further we propagate into the model, the more it decreases and it will vanish eventually and this is the "Vanishing Gradient " problem. This makes the model ineffective and very unstable in the first case and in the second case the model gets incapable of meaningful learning.Thus in a recurrent neural network it is hard to train a data set.[3]

IV. LITERATURE SURVEY

The number plate detection algorithms do not belong to only one category of pre-defined algorithms. Therefore, we may have to use various techniques for the same. We need to consider various factors while detecting number plate.

(1). Plate Location on the vehicle can vary from model to model.

(2). Plate Sizes can be different for different vehicles.

(3). Plate background color based on the vehicle type.

(4). Screw should not be counted as a character.

In the coming sections we will discuss about the various common number plate extraction methods according to various literatures.

1. Image binarization

This process is used to convert the image to black and white using a certain threshold value to classify any pixel as black or white. Selection of optimal threshold value is the key in this process. We can choose the threshold by manually feeding in the value or with the help of algorithms, also called as automatic thresholding.

2. Edge detection

This is a very common method for the extraction of features from a give number plate. It is used to identify object boundary with connected curves. This method

gets very difficult to use when we have complex figures as identification of connected curves becomes difficult. Algorithms used for edge detection are Differential, Sobel, Prewitt and Roberts Cross, Canny, Canny-Deriche.

3. Hough Transform

This technique is used for the detection of lines and shapes like circle or oval. The algorithm was generalized by D.H. Ballard [12].

4. Blob detection

To detect points that differ in color or brightness in comparison to surroundings. It is used as a complimentary for the edges or points left by the edge detection algorithms. Commonly used Blob Detectors are Laplacian of Gaussian (LoG), Difference of Gaussians (DoG), Determinant of Hessian (DoH), maximally stable extremal regions and Principle curvature-based region detector.

5. Connected Component Analysis

This method is used to label the subsets of connected components uniquely based as per connectivity as North-East, North, Northwest and West of the current pixel. It helps a lot in automated image analysis, plate segmentation as well as character segmentation.

6. Reviewing the work done in number plate detection

In the previous part we have discussed about the common approaches for the number plate detection. In the literature surveys covered next, there is a use of more than one approach. The different algorithms for number plate segmentation are discussed as follows.

In [13], for faster detection of region of interest (ROI) a technique called sliding concentric window (SCW) is developed. It is a two step method contains two concentric windows moving from upper left corner of the image. Then statistical measurements in both windows were calculated based on the segmentation rule which says that if the ratio of the mean or median in the two windows exceeds a threshold, which is set by the, then the central pixel of the windows is considered to belong to an ROI. The two windows stop sliding after the whole image is scanned. The threshold value can be decided based on trial and error basis. The connected component analysis is also used to have overall success rate of 96%. The experiment was carried out on Pentium IV at 3.0 GHz with 512-MB RAM and took 111ms of processing time for number plate segmentation.[26]

To detect multi-style number plate a configurable method is proposed in [14]. For detecting different style of number plates, a user can configure the algorithm by changing parameter value in the number plate detection algorithm. The authors define four parameters mainly:

- Plate rotation angle- to rotate number at certain angle plate if it is skewed which is shown in fig.6(a).
- Character line number – to determine whether characters are spanned in more than one line or column as shown in fig.6(b). The algorithm works for maximum three lines.
- Recognition models – to determine whether number plate contains alphabets only, alphabets and digits or alphabet, digits and symbols.
- Character formats – To classify the number plate characters based on their type. For example, Symbols can be represented as S, Alphabets can be represented as A and digits can be represented as D. So, the number in fig.6, can be represented as AADAADDDD.

(a)Skewed Image. (b)Number plate with lines

Fig6. Vehicle number plate with first two parameters as per [14]

The algorithm was executed on Pentium IV 3.0GHz. [26]

A cascade framework was used in [15] for developing fast algorithm for real time vehicle number plate detection. In this framework a compact frame detection module is used to segment number plate. This module contains three steps: First - Generation of Plate Region Candidates which is used to reject non plate regions by using gradient features. Second – Extraction of complex plate regions which contains three steps to identify plate

region and reject non plate regions. Third – plate verification is used to make sure that not non plate regions are extracted in preceding steps. The experiment was carried out on 3-GHz Intel Pentium 4 personal computer. [26]

To locate Indian number plate, a feature-based number plate localization is proposed in [16]. The authors use Otsu's method to convert gray scale images into binary images. It is a seven-step procedure to extract number plate without any background image from vehicle image. [26]

In [15] a feature salient method is used to extract vehicle number plate by using salient features like shape, texture and color. The authors used Hough transform (HT) to detect vertical and horizontal lines from rectangular vehicle number plate and then processed it by converting red, green, blue (RGB) to hue-intensity-saturation (HIS). Finally, the number plate is segmented. This algorithm is executed on Pentium-IV 2.26-GHz PC with 1 GB RAM using MATLAB. [26]

An Improved bernsen algorithm is used in [18] for license plate location. This algorithm is used for the conditions like uneven illumination and particularly for shadow removal. The authors used local Otsu, global Otsu, and differential local threshold binary methods for good accuracy. By using this algorithm, shadow was removed, and license plate was successfully detected, which was not possible with the traditional bernsen algorithm. The experiment was carried out on Windows XP Operating system Intel Core 1.8 GHz central processing unit and 1.5 GB RAM. The algorithm was developed using Visual C++.[26]

To detect license plate from CCTV footage, M.S.Sarfraz et al.[19] proposed a novel approach for efficient localization of license plates in video sequence and the use of a revised version of an existing technique for tracking and recognition. The authors proposed a novel solution for adjusting varying camera distance and diverse lighting conditions. License plate detection is a four-step procedure including finding contours and connected components, selection of rectangle region based on size and aspect ratio, initial learning for adaptive camera distance/height, localization based on histogram, gradient processing, and nearest mean classifier. After processing these steps final detection result is forwarded for tracking. [26]

In [20], canny edge detector operator was applied to find out the transition points. As per H.Erdinc Kocer et al a license plate contains white background and black character normally. The Canny edge detector uses a filter, which is then based on Gaussian smoothing's first derivative to eliminate the noise. Then in the next step, the edge strength is calculated by considering the gradient of the image. The canny edge detector operator used 3 X 3 matrix to accomplish this task. Based on this information transition points region is determined. The edge map is used to find transition points between black and white colors. The further technical details of this algorithm are not mentioned. The vehicle images were captures from CCD camera. [26]

In [21], global edge features and local Haar-like features are proposed for real-time traffic video. License plate detection is accomplished by moving a scanning window around the vehicle image. The scanning windows is categorized a license plate region and non-license plate region based on the pre-defined classifier. In the training phase, six cascade classifier layers are constructed for future processing. In the testing phase, local Haar-like features and global features are extracted. Haar-like features are the digital image features generally used for object segmentation. These features are generally collection of functions to find number of rectangles covering adjacent image regions. Global features include edge density and edge density variable. These features are calculated by using fix size of sample image i.e. 48 X 16 which is scaled in training phase. The experiment was carried out on a PC with Pentium 2.8 GHz CPU. The average processing time for segmentation was 0.204s. Another edge-based number plate segmentation algorithm is presented in [25]. [26]

To detect license plate in varying illumination conditions a novel approach is presented in [41]. A binarization method is used as pre-processing step for plate segmentation. In this approach, the author divided small window region in the image and applied dynamic thresholding method to each region. As per Naito, T et al. [23], this method is very robust for a local change in brightness of an image. Then binarized image is labelled and segmented as per the algorithm mentioned in this paper. The algorithm works for Japanese number plate, but it is not clear that whether it can be applied for other countries. The experiment environment and processing time are not mentioned. [26]

In [24] a novel approach based on vector quantization (VQ) is discussed. As per Zunino, R, most approaches focus on candidate regions like edge, contract etc in

segmentation process. It might segment non plate regions rather than plate regions. So VQ based approach is able to solve this problem. As per this paper a license plate is assumed be a rectangular box and each rectangle regions are considered as stripes. By using four-step codebook algorithm, a license plate is segmented. The system was developed under C++ language with Intel Pentium board running at 200 MHz having Windows NT operating system. The overall processing time including acquisition, location and OCR is about 200ms. [26]

Ref		**Success Rate (in %)**
[13]	1024 X 768	96.5
[15]	640 X 480	Not reported
[16]	Not reported	87
[17]	640 X 480	97.3
[18]	640 X 480	97.16
[19]	360 X 288 to 1024 X 768	94
[20]	220x50	98.82
[21]	648 × 486	96.4
[22]	640 X 480	89
[23]	640 X 480	Not reported
[24]	768 X 256	87.6

Table1. Number Plate Detection Rate and image size.

Now let's discuss about vehicle type recognition.

A. WEIJAN AND ET AL. PAPER

In the Paper proposed by Wei Jan [4] and et al. a convolutional neural network is used. They classify the vehicle in 5 classes namely Bus, Car, Motorcycle, Truck and non vehicle. Gradient Descent algorithm is employed wherein arrangements have been made that instead of updating the weight once all the image save been passed, the weight will be updated several times during the epoch. The optimizer here has been chosen as the Adam Algorithm which when compared to other techniques is proved to be more effective.[33][34].

	Dataset 1		***Dataset 2***	
	Type	***No. Images***	***Type***	***No. Images***
Classes of Vehicles	Bus	200	Bus	200
	Car	200	Car	200
	Motorcycle	200	Motorcycle	200
	Truck	200	Truck	200
			Non-vehicle	200
Total No. of Images	800		1000	

Fig7. Dataset 1 and Dataset 2

Dataset 1 has front view of the vehicle. Dataset 2 is an extension of dataset 1 with the inclusion some non vehicle images

	Dataset 3		***Dataset 4***			
	Type	***No. Images***	***Type***	***No. of Images***	***Type***	***No. of Images***
Classes of Vehicles	Bus	325	Bus (front view)	325	Bus (side view)	100
	Car	319	Car (front view)	319	Car (side view)	100
	Motor-cycle	326	Motor-cycle (front view)	326	Motor-cycle (side view)	100
	Truck	312	Truck (front view)	312	Truck (side view)	100
	Non-vehicle	200	Non-vehicle	200		
Total No. of Images	1481		1881			

Fig8. Dataset 3 and Dataset 4

Dataset 3 is an extension of dataset 2 having non-ideal conditions like dawn, night time, rainy and snow conditions. Dataset 4 is an extension of dataset 3 with the inclusion of side view of vehicles. The rear view is taken in none of the datasets.

Number of Convolutional Layer	*Validation Accuracy (%)*			
	Dataset 1	*Dataset 2*	*Dataset 3*	*Dataset 4*
1	77.50	79.37	89.56	94.69
2	98.75	94.99	91.92	96.55
3	62.50	88.50	87.54	93.37
4	66.25	75.62	90.91	93.10
5	25.62	84.50	80.13	73.21
6	25.62	19.50	14.14	32.89

Table 2: Validation Accuracy

Algorithm	Accuracy(%)	Time(ms)
LBP	46.3	2387
LGBP	68.9	3220
SIFT	77.8	3845
Linear SVM	88.1	1869
RBM	88.3	544
CNN	87.5	1280
TCNN	91.3	845
Ours	98.7	1030

Table3. Comparison Of Widely used Techniques

They found thay the optimum number of convolution layers was two to get the sweet spot for optimized time and cost. In the more ideal conditions of weather and illumination and angle of the image the accuracy increases. The main problem even greater than optimal conditions for the model was to identify between the truck and the bus.

B. YONGUO REN AND SHANZEN LAN'S PAPER

In this paper[35], the researchers have used deep convolutional neural networks and have tried to identify 42624 images from 233 fine-grained image categorizations. These images were taken from Compcars dataset [37] . They follow the architecture as 5 convolutional layers and 2 full connected layers. Here they are training on ILSVRC 2012 dataset consisting of 1.2 million datapoint and thousands of categories with 224x224 as size. They shifted each input image by 10px to create a neighboring image. The layers they used in CNN were convolution layer, batch normalization layer, Relu layer and softmax loss layer.

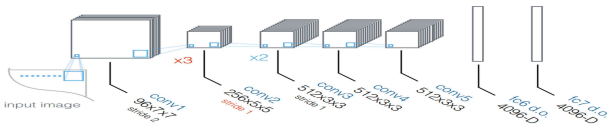

Fig9. The Architecture Used in Red and et al. paper

The input was taken to be frontal view of the vehicle.Different Techniques were employed and compared. As we can see the technique employed by the researchers which is proper pre processing of the image and integrating the batch normalization layer with the normal CNN the results have been outstanding.

V. CONCLUSION

Automatic number plate recognition can be extended beyond the normal use by including the following topic for vehicle owner identification, vehicle model identification traffic control, vehicle speed control and vehicle location tracking. For images that have been captured in lower resolution, improved algorithm can be used like super resolution [29]. We know that in real life scenario we will need to capture more than one number plate at a time and process it.

It is obvious that the number plate recognition system is not an easy work as we don't have a fixed algorithm or a fool proof method. Now with the current advancement it is not possible to achieve 100% overall accuracy, since each stage is depending on the previous stage.

The various factors like varying illumination conditions, vehicle shadow and non-uniform size of license plate characters, different font and background color cause a lot of difficulty in getting perfect recognition values for the number plate. Many of these methods are applied in a different way in need with different counties and their policies.

Conclusion on the survey on vehicle recognition is that in uncontrolled conditions the results were always less accurate than in controlled conditions. The major issues faced were the angle of photograph of the vehicle as the software gives better accuracy on recognition on certain angles namely rear view.

Along with this, CNN comes out to be the most optimal method used if integrated with batch normalization layer.

VI. PREWITT EDGE DETECTION ALGORITHM

This Algorithm is used as a discrete differentiation operator for Image Processing in Edge Detection Algorithms, it detects both Horizontal and Vertical edges and even shows us the image orientation and its magnitude and it does this by approximating the gradient of the image intensity function to detect image.

The Algorithm uses filters to get the edges ,two filters are used to get the final image ,the two basic filters are:

Vertical Filter

-1	0	1
-1	0	1
-1	0	1

Horizontal Filter

1	1	1
0	0	0
-1	-1	-1

Algorithm

p1	p2	p3
p4	p5	p6
p7	p8	p9

Now assuming a 3×3 Matrix, with pixels(P1 ,P2……P9) with p5 being the centered pixel the new resultant pixel P5' is now calculated using the formula

P5'=(P1+P2+P3-P7-P8-P9)+(P3+P6+P9-P1-P4-P7)

The result will be brought between the 0 -255 range

VII. SIMULATION AND LOGIC OF THE CODE

Neural Networks:

In the simulation we are writing the matlab code having 15 training data and out of that for the reference of comparison we are taking the mean and then we will put the data to be tested it is going to compare it with the mean value and then give the closest result .

Image Processing Algo:

The function "imread" is used to read an image file from the system, in this case, it is being stored in variable named A,B,C……,Z and then for numerals we have the same function, to read the images for each and every numeral, that is, 0,1,2,3….,9 and store them in respective variables zero,one, two, three….nine.

All the letter variables are added into an array for letters and similarly for numbers we add them into an array to keep them as a collection for using loop operations.

Then we create a template. A template is a format for any data. Here we create a template in a way such that it is a collection of numbers and letters, and we save it as a file, so that we can use this template/format in future use of the program codes.

Then, we created a new file called as Letter Detection for the purpose of character detection.
A function named letter is created, which gives us the output from the input image in alphanumeric form, using the method "readLetter()". This takes the value of snap , snap contains the images.
Then we load the template which we saved previously to store the values in desired format. This will help us to compare the images with the template images.

Then, we resize the image that is in the snap using the "imresize" function. [42 24] refers to the desired size, imresize takes 2 inputs in this case, 1st one is the image that has to be resized, the 2nd one is the desired size in columns and rows. Then this resized value is stored into the same variable, snap. So now, snap contains the resized images according to our convenience.

The for loop is used to correlate the input image, with the images in the template. This is done to get the best match to find out what the given character most probably looks like. A matrix "rec" os created which stores the correlation for each of the alphanumeric templates along with the character templates form the input image when we use "cor = corr2(arguments)".

This gives us an index and then we use the "find" option to compare which index matches the most with our image, and we print the value using the "if-else" statement.

Then create a third file for number plate detection.

"Imread" is used to read the image from the user with the location given.
Then we use "rgb2gray" to convert the input image into grayscale format and store it in variable "imgray". "Imbinarise" is used to convert the grayscale image into black and white format and store it in variable "imbin". "Edge" command is used to detect edges in an image by using various methods like Roberts, Prewitt etc.

"Regionprops" function is used to find the various properties of a given region. Here the input image is "im" which is the edge selected gray image. Then we assign the value of the selected area and using "numel" we calculate the total number of array elements. Boundingbox is used to determine the location of the number plate in the image, and to select only the area of our interest, that is the number plate. Then a for loop is written to find a bounding box around every element of the array. Array here is the list of all alphanumeric characters on a number plate. This is done to find a bounding box around all separate characters so that each one can be worked on separately for pattern matching.

"Imcrop" is used to crop the number plate to only get the number plate out of the entire input image. Then, "bwareaopen" is used to remove all the small objects from a number plate that are just noise for our input.

This code is used to process the final cropped image and to display the detected number plate in the text format. Iprops stores the image properties in the array. Then we run the for loop on each and every element in the array to find out each and every character and then convert it into text Format. Oh and we specify object height and object width respectively. Then we call the letter detection function which we wrote a separate code for to get the desired letter using pattern matching. We ran the code on matlab version 2019b .

VIII. RESULTS

In the result when we have put the 6 data to be tested here it shows the output according to the training data that has the maximum similarity that is 5 matching and 1 is not matching .if we put data from the training set it shows the exact result and if we put any random data it will show the closest matching data to that.

Image Processing Algo:

We ran 15 test cases and we found out that 11/15 were correctly identified and in others' case the program was simply showing a straight line, horizontal in some cases and vertical in others.

XI. POTENTIAL IMPROVEMENTS ON THE DRAWBACKS OF THE PREWITT EDGE DETECTION ALGORITHM

Disadvantages and Drawbacks of the Prewitt Edge Image Processing Algorithm

- This algorithm does not work effectively for twisted or turned Number Plates or Number Plates which are damaged in any sort of way .
- It does not work if any light is shining or if there is any obstruction of view for the Number Plate .
- The Algorithm will be ineffective if some of th numbers have been scraped out or edges are not proper, it could mistake a number, for an alphabet or any other symbol or not recognise it at all.
- It will not work if the Number Plate of the car falls outside the bounding area of the given image, since it will not read the number plate.

Improving the drawbacks of Prewitt Image Edge Processing Algorithm

- The Camera position has to be placed in such a way that there is no obstruction of view of the number plate .
- To solve the bounding area problem a bigger bounding area could be used ,one that accommodates all the possible positions of the number plates and crops out the unnecessary area leaving only the license plate.
- For different cases , different algorithms are used so that the best fitting algorithm can be used for that particular case.

X. CONCLUSION

This is the simple model of image recognition can be made more dynamic by adding more training sets having different types of data's as it will increase the accuracy of the result.

We tried both image processing algorithm and the neural network version also and we found out that without much training the image processing algorithm works almost flawlessly. Here instead of the strength of the mathematical algorithm as in case of neural network here the preparation of image and camera angle at which picture were take are more important.

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